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Focus on Incorporating Tilapia into Shrimp Aquaculture

Recently the PD/A CRSP received an inquiry from an aquaculturist in Panama troubled by the lethal white spot syndrome virus, which has caused shrimp production in Panama to drop; he was seeking advice on converting from shrimp culture to tilapia culture or shrimp-tilapia polyculture. The CRSP contacted program participants Kevin Fitzsimmons, who has assisted farmers with transitions from shrimp to tilapia production or shrimp-tilapia polyculture, and Carole Engle, who is investigating the development of domestic tilapia markets in Central America, to respond to this inquiry. Recent news stories dealing with Ecuadorian shrimp producers converting to tilapia culture (see article, p. 4) and a discussion on the tilapia and shrimp e-groups discussion lists (online at <www.egroups.com/group/tilapia> and <www.egroups.com/group/shrimp>) prompted us to invite Engle and Fitzsimmons to contribute articles discussing the considerations that shrimp farmers should weigh in deciding whether to switch to tilapia production or shrimp-tilapia polyculture.

Tilapia and Penaeid Shrimp Polycultures

by Kevin Fitzsimmons

White spot and other diseases have affected marine shrimp production in several countries, including Ecuador, Panama, Mexico, and Thailand, in recent years. In response, some shrimp farmers have turned to polyculture or crop rotation with tilapia as an alternative production system. Polyculture options include growing the fish and shrimp loose in the pond, keeping tilapia in floating net pens in the pond, and sequential polyculture—growing shrimp and tilapia in separate ponds or raceways and exchanging water between the ponds. Crop rotation involves stocking tilapia into ponds between shrimp crops. There are several advantages and disadvantages to consider before attempting shrimp-tilapia production.

In addressing disease issues, tilapia-shrimp polyculture provides advantages in several ways. Growers in Ecuador have reported that tilapia will consume dead or moribund shrimp in polycultured ponds. Cannibalism is one of the primary vectors for transmission of viral shrimp diseases. Tilapia, which do not appear to be susceptible to or carriers of these viruses, limit cannibalism as a mode of transmission. Tilapia also consume small crustaceans, which are of concern as potential disease vectors, in shrimp ponds. Stocking tilapia directly in the

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Raising Tilapia in Shrimp Ponds: Economic and Marketing Considerations

by Carole Engle

Aquaculture businesspeople often turn their attention to new species when prices fall or other problems emerge. The white spot virus has driven many shrimp farmers to consider switching to tilapia production. The switch to any new product should be analyzed carefully before committing resources. The key to the economic feasibility of such a change is whether the shrimp farmer will be able to develop a market for tilapia that will provide a price greater than his/her costs of production.

The US market for tilapia fillets has demonstrated dramatic growth in recent years. However, the US market requires a very high-quality fillet. Most companies exporting tilapia from Central America to the US have created their own US marketing companies to handle their products. These companies have developed markets through intensive efforts to provide samples, point-of-sales information, and complete customer support. To maintain a marketing company in the US requires a substantial quantity of tilapia fillets to be

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ponds, or alternating tilapia with shrimp in a crop rotation, can be effective in reducing crustacean populations. The incidence of bacterial infections also may be lessened by polyculture. *Vibrio* and most other bacterial pathogens common in shrimp culture are gram negative, while waters which have been used for finfish culture tend to be predominated by gram-positive bacteria. Using water from a fish culture pond seems to reduce the prevalence of bacterial infections in shrimp ponds. Growers in Asia and South America have reported increases in shrimp production due to higher survival in some of these polyculture systems; however, carefully controlled and replicated trials are needed to better study these systems and confirm these reports.

There may also be physical factors that improve shrimp survival and growth in polyculture and crop rotations. The effect of bottom sediment disturbance by tilapia is not well understood and will require close attention and careful experimentation. Tilapia disturb bottom sediments to a greater degree than shrimp, both in foraging and nest-building activities, which may be beneficial in several ways. Disturbing the bottom may improve oxidation of the substrate and interrupt life cycles of shrimp pathogens and parasites. It may also release nutrients into the water column that could improve algae blooms. However, it is also possible that these activities are detrimental. Disturbing bottom sediments may negatively impact water quality by lowering dissolved oxygen levels, increasing turbidity from sediments, and reducing algae blooms. It also makes it difficult to remove fish and shrimp, and most certainly increases the need to repair pond bottoms between crops.

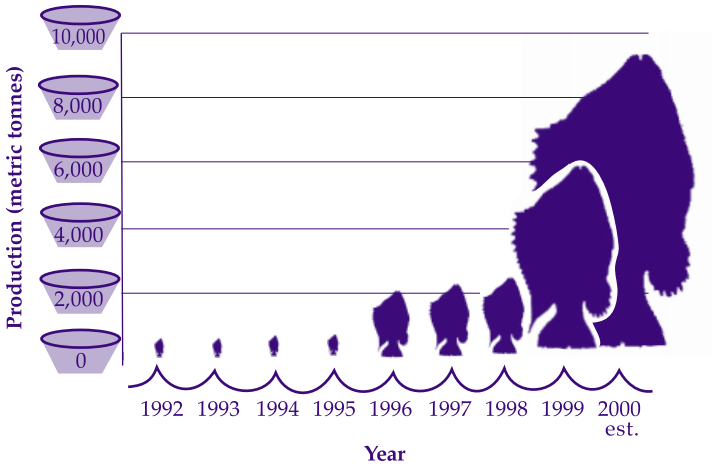

Figure 1. Tilapia production in Ecuador.

Nutritional impacts are another aspect of shrimp-tilapia polyculture that should be considered. Several farmers already practicing polyculture report that tilapia aggressively feed on shrimp pellets, which may impact the shrimp growth. Freshwater shrimp (*Macrobrachium rosenbergii)*–tilapia (*Oreochromis niloticus*) polyculture reduces the yield of prawns compared to monoculture, but increases total yield of fish and prawns (Garcia-Perez et al., 2000). Penaeid (saltwater shrimp)–tilapia polyculture seems to be subject to the same effect. Cage culture of the tilapia, sequential polyculture, and crop rotation would avoid this problem. Considering that both shrimp and tilapia are opportunistic detritovores, wastes and feed from either may provide food for the other.

The harvest of shrimp-tilapia polyculture ponds presents several difficulties. Separating fish and shrimp if

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Table 1. Advantages and disadvantages of shrimp-tilapia polyculture.

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Diseases	Tilapia may eat diseased shrimp Tilapia may eat other viral hosts May encourage beneficial bacteria	Tilapia may be pathogen hosts Crustacean parasites on tilapia could be vectors
Pond Environment	Tilapia can improve sediment ecology Tilapia may improve water quality	Tilapia may degrade sediment ecology Tilapia may degrade water quality Tilapia nests leave bottom pockmarked
Harvest		Hard to separate fish and shrimp at harvest May need to buy nets, or arrange separate grow-out
Nutrition	Wastes may be mutually beneficial Tilapia can eat feeds unsuitable for shrimp	Tilapia may consume all feed, starving shrimp
Processing	Much shrimp equipment adaptable	Requires several new pieces of equipment
Marketing	Most infrastructure and connections useful	Requires investment in market development to increase demand
Economics	Often leads to increased profitability	Requires additional investment

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they are grown together is time consuming and requires graders or hand sorting. Netting fish from a pond before the shrimp harvest is not practical because tilapia are adept at going over and under nets.

Processing and marketing are areas where shrimp producers have some equipment and infrastructure but will need additional investment when / if they convert to polyculture. Existing haulers, chill tanks, weighing tables, freezers, and cold storage will be useful, but scalers, eviscerators, skinners, and fillet equipment specific to tilapia processing would need to be added. Shrimp producers have valuable connections to seafood brokers and buyers but will need to make additional investment in marketing to create new demand. Although demand for tilapia has been rising rapidly, tilapia production is increasing just as rapidly around the world. Prices for tilapia products have decreased in many markets as supply increases. If additional products are to be brought in by shrimp farmers, substantial investments in market development should be made to keep prices from further eroding.

Ecuador provides the best example of the integration of tilapia into shrimp production. But several farmers have since converted completely to tilapia, rather than continue to practice polyculture, after determining that monoculture of tilapia was more economically attractive. Both monoculture and polyculture have contributed to the explosion of tilapia production in Ecuador in recent years (Figure 1).

It should be noted that the first serious outbreak of Taura Syndrome in the shrimp industry in Ecuador, in 1992, contributed to the first boom in tilapia production. Following that boom, prices for tilapia products softened in the US and production stagnated. The outbreak of white spot in 1998 led to the current rapid increase in tilapia production. If shrimp farmers learn to manage white spot, we may see a similar plateau in tilapia production. Farmers in Thailand, Mexico, and Brazil are also experimenting with shrimp-tilapia polyculture (Fitzsimmons, 2000).

Given the relative lack of understanding of the costs and benefits of shrimp-tilapia polyculture, growers should carefully weigh the pros and cons (Table 1) before committing to a change in production.

Literature Cited

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Garcia-Perez, A., D. Alston, and R. Cortes-Maldonado, 2000. Growth, survival, yield, and size distribution of freshwater prawn *Macrobrachium rosenbergii* and tilapia *Oreochromis niloticus* in polyculture and monoculture systems in Puerto Rico. J. World Aquacult. Soc., 31(3):446–451.

Kevin Fitzsimmons, of the University of Arizona, is a member of the PD/A CRSP Technical Committee, and Vice President of the American Tilapia Association.

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supplied each week on a consistent basis. The advantage of exporting to the US is that it brings a higher price, but it also requires a large tilapia (650 g).

An alternative to exporting is to develop a domestic market in Latin America. Such a market has developed in Colombia and has contributed stability and diversity to its tilapia industry. Yet it will take a very concerted effort in most other countries to overcome the perception on the part of many consumers that tilapia is a low-quality, poor people's food item. Wild-caught, often off-flavor, tilapia is sold in many countries, and the off-flavor contributes to tilapia's poor reputation. To capture the higher prices that will be necessary to cover farm production costs, markets for larger, purged tilapia will need to be developed. The recent CRSP-funded surveys conducted in restaurants and supermarkets in Honduras and Nicaragua by University of Arkansas at Pine Bluff researchers Ivano Neira and Carole Engle seem to indicate potential for tilapia to be offered as a "Catch-of-the-Day" to diversify seafood menus and to provide a consistent supply of fish. [*Ed. note*: For more on Neira, see the Graduate Student Profile in this issue, p. 5. Preliminary results of the survey will be published in the forthcoming *PD/A CRSP Eighteenth Annual Technical Report*.] Supermarkets prefer a smaller, 0.5-lb whole-dressed product. Both market channels require purging that involves holding tanks and adequate flow of clean, non-chlorinated water. Customer support in the form of point-of-sale materials, recipes, in-store samples, and promotion will be essential to assist restaurants and supermarkets to develop tilapia sales. Farm-raised tilapia must be differentiated from wild-caught fish as a consistently high-quality, taste-tested, and purged product.

Green and Engle (2000) estimated production costs to be US$1.72 kg^{-1} to cover total costs of 250-g tilapia that could be supplied to supermarkets. For a larger fillet for restaurants, breakeven prices were $5.37 kg^{-1} of fillet to cover total costs. Clearly much work needs to be done to position tilapia as a higher-valued product in many markets in Latin America.

Literature Cited

Green, B.W. and C.R. Engle. 2000. Commercial tilapia aquaculture in Honduras. In: B.A. Costa-Pierce and J.E. Rakocy (Editors), Tilapia Aquaculture in the Americas, Vol. 2. The World Aquaculture Society, Baton Rouge, Louisiana, USA, pp. 151–170.

Carole Engle is Project Leader for CRSP Marketing and Economic Analysis Research at University of Arkansas at Pine Bluff.

Mon Defends Master's Thesis

Congratulations to Ms. Aye Aye Mon on the successful defense of her master's thesis in August 2000. Mon, a citizen of Burma, worked on PD/A CRSP New Aquaculture Systems/New Species research under the direction of CRSP Co-Principal Investigator Kwei Lin at the Asian Institute of Technology, Bangkok, Thailand.

Use of lotus (*Nelumbo nucifera*) for nutrient retrieval from pond mud

(abstract of Aye Aye Mon's M.S. thesis)

This study was conducted during February to June 2000 to investigate nutrient removal efficiency by lotus (*Nelumbo nucifera*) from fish pond mud and to evaluate economic return of lotus cultivation in fish pond at the Asian Institute of Technology. This experiment was conducted in twelve compartments (3 x 2 m) in an earthen pond with a randomized complete block design. There were four treatments with three replicates each: no lotus planted (treatment A); lotus planted at 0.5, 1, and 2 rhizomes/m^2 (treatments B, C, and D, respectively). There was no nutrient input to the lotus cultivation system, and lotus growth depended solely on the nutrients contained in mud of the fish pond, which was used for intensive fish culture three months prior to the present experiment.

Increased density of planted rhizomes did not result in any significant differences in net and gross production of both total lotus biomass and rhizomes among treatments B, C and D ($P>0.05$). The net and gross biomass production reached more than 120 t/ha/year in treatment B and C. The highest net and gross rhizome production was achieved in treatment C, reaching 35 and 38 t/ha/year, respectively.

Lotus recovered 1.73-2.5 % of total nitrogen (10.1-14.5 g/m^2) and 0.63–0.99 % of total phosphorus (1.2–1.6 g/m^2) from pond mud in treatments B, C and D. The reduction of both total nitrogen and total phosphorus in pond mud in treatment C was significantly higher than that in the control. Partial budget analysis showed that net return from lotus cultivation in fish pond ranged from 9,234 to 12,599 US$/ha/year, without significant differences among treatments B, C and D.

This study has successfully demonstrated the practicality to cultivate lotus in fish pond for removing nutrients from pond mud and achieve high economic return. Lotus cultivation in fish pond is feasible technically, environmentally and economically.

Tilapia Farming Could Be a Good Alternative for the Shrimp Sector

by Carlos Adeler

Ecuadorian shrimp producers are considering turning their shrimp ponds, today inactive due to the white spot virus, to tilapia farming. With the present infrastructure, and providing considerable investments in technology are made, Ecuador could produce fresh tilapia for the US market. The incorporation of good technology is vital, if the Ecuadorian product is to compete against the product from Taiwan or Costa Rica. Presently, the major tilapia exporters are Taiwan, Costa Rica, Indonesia and Ecuador. About 92% of the tilapia imported by the US is frozen (whole fish and fillets), and comes from Taiwan. Ecuador would not be able to compete with Taiwan's prices, but it could take part in the fresh tilapia market, competing with Costa Rica. Ecuador is among the world's largest producers of fresh tilapia, with Costa Rica, Honduras and Jamaica. However, the fact that these countries have cheaper transport costs and more regular aerial freight services represents a disadvantage for Ecuador. Usually, the water of inactive shrimp ponds has a salinity of 15ppm (parts per million). Although tilapia is a fresh water fish, Ecuadorian red tilapia is a hybrid that can live both in fresh and salt water. However, the fish suffers from stress when the salinity of the water exceeds 15ppm, and above 20ppm, its culture is a complete failure. It is estimated that an investment of about US$7,500 per hectare of water is required to turn a shrimp pond into a tilapia pond. Additionally, it is necessary to set up a laboratory that can ensure a constant supply of fingerlings and fresh water, with a minimum investment of US$250,000 to US$500,000, and a working capital of US$5,500 per hectare of water is also required. Tilapia needs between ten and 11 months to reach a commercial size from the moment the fingerlings - weighing approximately 0.5g - are received until the moment when the fish reaches an average weight of 840g. In addition, producers often have to wait for a further 40-50 days, after production is delivered in consignment, to be paid. Tilapia is still affected by bacteria and parasites which bring on considerable damages, although they can be controlled with medicines. It is estimated that about three or five years will be necessary to develop a proper genetic species.

Source: *Fish Info Service, <fis.com/fis/hotnews/>, 4 May 2000.* Reprinted with permission.

Graduate Student Profile: Ivano Neira

by Anu Gupta

Developing countries, world cultures, and fish: these are all interests held by CRSP graduate student Ivano Neira. As such, his work with the PD/A CRSP fits him perfectly.

Neira is a Master's degree candidate at the University of Arkansas at Pine Bluff, where he is working with researcher Carole Engle on a CRSP-sponsored activity entitled "Development of Central American Markets for Tilapia Produced in the Region," which focuses on tilapia production in Honduras and Nicaragua.

One of the major objectives of this activity is to identify potential domestic markets for tilapia. Tilapia aquaculture in Honduras and Nicaragua has exploded in the past ten years, but the majority of the product is exported. By identifying potential local buyers, the researchers hope to encourage growth in the domestic tilapia market. The activity, including Neira's part, is funded exclusively by the CRSP.

Neira recently returned from a trip to Nicaragua, where he conducted surveys of restaurants, supermarkets, and fish markets. Neira will use the survey results to identify characteristics of fish buyers who are likely to buy tilapia, and then develop recommendations for marketing strategies to be used by different sizes of tilapia farms in various target markets. He will conduct part of the analysis on the survey results. In one section, he will use a logit analysis to relate buyer preferences and characteristics to their probability of purchasing tilapia, and in a second part, he will develop a transportation cost model to identify target markets for different tilapia farm sizes in different regions of Honduras and Nicaragua.

Having the chance to travel to Nicaragua was something Neira greatly enjoyed. He has done a lot of traveling just to get to this point in time in his life. Neira is originally from Lima, Peru. He received his undergraduate degree in Fishing Engineering from Agraria University, also in Lima, in 1995. He then turned his attention to agricultural business, in which he received a post-graduate certificate.

Ivano Neira (far right) visited a local fish market in Managua during a recent trip to Nicaragua.

From Lima, Neira then moved to Aquafuture, Inc., in Turner Falls, Massachusetts, where he worked with striped bass, then to Bioshelters, Inc., in Amherst, Massachusetts, where he worked on recirculating systems for tilapia. One of the reasons he decided to come to the US was to improve his English language skills. He was also interested in applying his knowledge of recirculating systems to real-life situations. His manager at Bioshelters, Inc., knowing that Neira was interested in continuing his education, told him about the research position with Engle, which was advertised on the popular aquaculture website "AquaNet." From there he moved to Pine Bluff, where he entered the CRSP pond.

"I'm interested in helping developing countries," he said, pointing out that his home, Peru, is also a developing country. He is particularly interested in estimating fish markets and determining ways to sell fish. "I would like to have more knowledge and background applicable to my country and other countries, in order to help them."

Neira hopes to finish his degree by December 2001. The work of international organizations interests him, and he sees himself working on further projects for developing countries after he graduates.

The spark that set Neira off on this aquaculture track was his own backyard. "When I was a little kid I was always interested in all kinds of life—especially doing experiments. My house was a zoo. I had all kinds of small animals (a rabbit, mouse, snakes, frogs, ducks, chickens, etc.). When I was eight years old I was on the shore of a pond, and I caught some fish which I took home with me. I started to grow ornamental fish (spawning them and doing experiments)." He continued growing ornamental fish until he left for the US.

Neira doesn't find himself with much free time outside of his research, but in his spare time he does like to run and read books. Luckily, one of his greatest interests, traveling, fits in with his research needs: "I like to travel a lot, and know more about cultures." Neira is optimistic that the current CRSP activity will have applicability in countries beyond just Nicaragua and Honduras: "I would like to do research in all of Central America, but I know that is too broad." With goals such as his, however, Neira is certain to spread ripples throughout and beyond the CRSP pond.

IIFET 2000: A Multidisciplinary and Multinational Success

by Deb Burke

The International Institute of Fisheries Economics and Trade (IIFET) 2000 Conference: *Microbehavior and Macroresults* was diversity exemplified—in both its subject matter and participants. The conference, held at Oregon State University from 10 to 14 July 2000, offered a multidisciplinary cross-section of sessions on the unique economic, social, and biological issues associated with fisheries and aquaculture development, hosting more than 500 individuals from over 45 countries.

Participants at IIFET 2000 represented countries from around the world, including Estonia, Poland, Bangladesh, India, Malaysia, Philippines, Thailand, Cameroon, Ivory Coast, Kenya, Malawi, Morocco, Nigeria, Sierra Leone, South Africa, Togo, Brazil, Chile, Mexico, and Trinidad and Tobago. Of particular note was the value of the conference in bringing the realities and challenges of fisheries and aquaculture development from these countries to the forefront.

The IIFET 2000 Conference was the largest to date, including 500 presentations in 81 sessions. Sessions ranged from topics such as *Ecology and Theology* to *Price Analysis and Demand Estimation*. In addition to sessions on fisheries, there were sessions focused on the socioeconomic aspects of aquaculture in developing countries, including a number of presentations by researchers from PD/A CRSP host countries. Presentations delved into the social and economic issues associated with aquaculture development for coastal communities in Mexico, the adoption and economics of tilapia farming in the Philippines, shrimp culture development in Thailand, and the socioeconomic impacts of aquaculture support programs in Kenya.

IIFET 2000 organizers are already looking toward future conferences. They are excited to incorporate multiple perspectives into the design of future conferences, thus creating opportunities for enhanced information flow and the identification of creative solutions to complex fisheries and aquaculture issues.

Comments from international participants reflected their positive experiences at IIFET 2000:

- The diversity of both attendees and topics presented made IIFET 2000 a positive experience for me. It was particularly satisfying to see people from different disciplines actively working for a greater understanding of shared problems through open dialogue. (*participant from Uruguay/US*)

- The exchange and discussion of experiences and knowledge has broadened the research perspectives and methodology approaches that can be developed in Mexico regarding the integration of aquaculture practices within the fishery sector…important impacts on rural communities and how they relate to livelihood…sustainability. (*participant from Mexico*)

- The conference once again validated the two most important features of an international conference of this magnitude… 1) the need for the interface of various disciplines in the biological, technical, behavioral, and social sciences in tackling issues and problems confronting a very important and strategic field…fisheries, aquaculture, and their allied sectors such as regulation and enforcement; environmental and ecological concerns; international trade and marketing; social ramification… and 2) the importance of partnership, linkages, and networking among and between governments, universities, research institutions, and the private sector in advancing the cause of fisheries and aquaculture. (*participant from Asia*)

IIFET was founded in 1982 to promote interaction and exchange between people from all countries and professional disciplines on marine resource economics and trade issues. Among the many interests of IIFETs members are fisheries economics, seafood markets throughout the world, aquaculture development and economics, and fisheries development. Industry members, government and academic researchers, and managers from over 60 countries benefit from membership in IIFETs network and activities. More information about the organization can be found on the Internet at <osu.orst.edu/dept/IIFET>.

The PD/A CRSP cosponsored IIFET 2000 and provided the following researchers working in PD/A CRSP host countries the opportunity to attend and present:

Eunice Pérez Sánchez, Institute of Aquaculture, University of Stirling, UK, *Aquaculture Impacts in the Socio-economics of the Coastal Communities of Tabasco, Mexico* (online abstract: <osu.orst.edu/dept/IIFET/2000/abstracts/sanchez.html>)

Ruben Sevilleja, Freshwater Aquaculture Center, Central Luzon State University, Philippines, *Adoption and Economics of Tilapia Farming Technology in the Philippines* (online abstract: <osu.orst.edu/dept/IIFET/2000/abstracts/sevilleja.html>)

Ruamporn Sirirattrakul, National Statistical Office, Thailand, *Dramatic Development of Shrimp Aquaculture in Thailand (based on the 1985 and 1995 Thai Marine Fishery Census)* (online abstract: <osu.orst.edu/dept/IIFET/2000/abstracts/sirirattrakul.html>)

Mathias Wafula, Fisheries Department, Kenya, *Socio-economic Impact of Aquaculture Support Programmes on the Communities in the Lake Victoria Basin of Kenya* (online abstract: <osu.orst.edu/dept/IIFET/2000/abstracts/wafula.html>)

In addition, the director of the PD/A CRSP, Dr. Hillary Egna, participated in a session that explored interdisciplinary approaches to issues in fisheries:

Research and Teaching: Across Disciplines, Countries, and Universities (session information online at <osu.orst.edu/dept/IIFET/2000/sessions/resteach.html>)

It's a Small Pond After All

Have you ever run into an old friend or professor from long ago in an unlikely location? Well, that's just what happened to Eunice Pérez Sánchez when she visited Oregon State University to attend the tenth biennial conference of the International Institute of Fisheries Economics and Trade (IIFET 2000).

XENA CUMMINGS

Wilfrido Contreras-Sánchez and Eunice Pérez Sánchez renew an old acquaintance during a break from IIFET 2000 in Corvallis, Oregon.

Pérez was among four host country scholars sponsored by the PD / A CRSP to attend IIFET 2000. At a dinner for the CRSP-sponsored conference participants she ran into one of her professors from the Universidad Juárez Autónoma Tabasco (UJAT) in Mexico—Wilfrido Contreras-Sánchez, a CRSP researcher investigating reproduction control. The two had worked together in Contreras' lab at UJAT beginning in 1995. After working in the lab over several years, Pérez continued on to do her bachelor's thesis on the induction of reproduction with gars (*Atractosteus tropicus*) and collaborated in a research program for integrated rural development at UJAT. Currently, Pérez is in the process of completing her Ph.D., "Coastal aquaculture and resources management in Mecoacan estuary, Tabasco, Mexico," at the University of Stirling, Scotland. After completing her doctorate, she plans to return to Mexico to develop integrated aquaculture projects for the coastal zone of Tabasco. Contreras is wrapping up his Ph.D., "Mechanisms of sex inversion in Nile tilapia (*Oreochromis niloticus*)," at Oregon State University and plans to return to his professorship at UJAT in November.

Kudos

Research sponsored by the CRSP and headed by Martin Fitzpatrick and Wilfrido Contreras-Sánchez was highlighted in a recent article in Aquaculture Magazine (Vol. 26, No. 3, May / June 2000). In his regular column entitled "Research Reports," author James Avault, Jr. highlighted seven of the nearly 400 reports presented at Aquaculture America 2000, held 1–4 February 2000 in New Orleans, Louisiana. One of those seven was Contreras, Fitzpatrick, and Carl Schreck's paper entitled "Masculinization of Nile tilapia (*Oreochromis niloticus*) by immersion in trenbolone acetate," presented by Contreras. The study examined immersion in trenbolone acetate (TA) as an alternative to administration of methyltestosterone (MT)-treated food as a masculinizing agent. While TA was not as efficient as MT in masculinizing tilapia, it may pose fewer environmental risks. Stay tuned for the upcoming PD / A CRSP *Eighteenth Annual Technical Report*, which will include a final report from this project, describing the study in more detail.

University Day Exposes OSU to CRSP

What do a velcro tilapia tail, Thai fish identifications posters, photos of *Colossoma*, and a gummy shark all have in common? They all *lured* people in to the PD / A CRSP display during the annual University Day event held at Oregon State University (OSU) on 18 September 2000.

The annual event is held to introduce new faculty and staff to the variety of departments at OSU and to recognize exemplary faculty and staff. The PD / A CRSP hosted an information booth with literature, a photo display, food, and games. Free fish crackers enticed passers-by to look at the displays, leaf through publications and pamphlets, join a raffle, and play a "Pin the tail on the tilapia" game, which involved a velcro fish tail on a felt backing. The prize for pinning the tail in the correct place was a large blue and white gummy shark.

The CRSP has participated in several of the previous years' University Days. Past enticements have included tilapia recipes and poetry contests. More important, however, was the number of new faculty and staff who have been intrigued and excited by the CRSPs work.

KRIS MCELWEE

The PD/A CRSP Information Management and Networking Component hosted a booth at University Day to familiarize the OSU community with the work of the program.

ISTA 5—Rio de Janeiro Hosts Tilapia Conference

by Kevin Fitzsimmons

The Fifth International Symposium on Tilapia Aquaculture (ISTA 5), held in Rio de Janeiro, Brazil, from 2 to 7 September 2000, was the best attended ISTA to date. Almost 600 participants from over 40 countries attended. The proceedings included over 100 papers, which were published in two volumes. The proceedings were distributed to the participants at the meeting, and the two-volume set is also available for $50 (plus shipping) from the American Tilapia Association <www.tilapia.org>.

The conference was also used as the debut for three new books on tilapia aquaculture. Fernando Kubitza released his book *Tilapia* in Portuguese, providing an excellent overview of tilapia aquaculture. The World Aquaculture Society (WAS) released a new book, *Tilapia Aquaculture in the Americas, Volume 2*. Stirling Aquaculture and Kluwer Publishers also distributed announcements of their new text, *Tilapias: Biology and Exploitation*.

ISTA 5 attendees included, from left to right, CRSP sponsoree and Philippines Project Principal Investigator Remedios Bolivar, CRSP Director Hillary Egna, program participant Jim Szyper, sponsoree and former CRSP graduate student Daniel Jamu, conference organizer and CRSP Technical Committee member Kevin Fitzsimmons, and sponsoree and Thailand Project researcher Yang Yi.

The social events were well attended, although the spectacular views from the Sugar Loaf were spoiled by an untimely rainstorm. The tilapia dinner at the Sofitel Hotel had almost 600 in attendance. The dinner featured several tilapia recipes, all of which met with rave reviews. The farm tour to Minas Gerais State had great weather, and everyone had a chance to enjoy the scenery going from the beaches of Rio to the mountains of Minas. One of the popular additions to the ISTA format was a tilapia gastronomic circuit. Several of the surrounding restaurants featured tilapia on their menus during the conference, and attendees were able to try several new recipes. This gastronomic circuit and conference was featured in a great article in the Sunday paper of Rio, the restaurants got plenty of free publicity, tilapia has made it onto the menus of several new restaurants, and several farmers now have new customers. This feature will probably be added to all future ISTAs as an addition to the technical sessions, Farmer-to-Farmer sessions, and trade show that have made these conferences so important to the industry.

The Tilapia International Foundation also instituted an award in the name of Father Jan Heine, recognizing a person who has made major contributions to helping small tilapia farmers in developing countries. The inaugural award went to Hans Middendorp in recognition of his work in Cameroon, Thailand, Vietnam, and Bangladesh.

A committee was also formed to begin plans for ISTA 6, which will be held in Manila, Philippines, in September of 2004.

PD/A CRSP Contributes to ISTA 5 Success

The CRSP made quite a splash at ISTA 5, with CRSP participants assembling from all over the world. The PD/A CRSP was one of the conference cosponsors, with Director Hillary Egna one of the speakers opening the conference. In a short talk during the plenary session, Egna gave an overview of the PD/A CRSPs ongoing research priorities in tilapia aquaculture. Egna, along with other introductory speakers, spoke to an audience of over 500 researchers and tilapia enthusiasts. She also chaired one of the regional sessions.

The CRSP also sponsored three scholars with current and past PD/A CRSP ties to travel to Brazil and present papers at the meeting. One of the scholars was Remedios Bolivar, of the Freshwater Aquaculture Center, Central Luzon State University, Philippines. She presented two papers: "Response to selection for body weight of Nile tilapia (*Oreochromis niloticus*) in different culture environments" and "Timing of the onset of supplemental feeding of Nile tilapia (*Oreochromis niloticus*) in ponds." These were presented during the Genetics and Reproduction and Pond Management sessions. Bolivar is the CRSP Philippines Project Host Country Principal Investigator.

Kevin Fitzsimmons and Jomar Carvalho Filho, organizers of ISTA 5, look on as CRSP Director Hillary Egna delivers remarks at the opening Plenary Session.

Yang Yi, of the Aquaculture and Aquatic Resources Management branch of the Asian Institute of Technology, Thailand, presented "Analyses of various inputs for pond culture of Nile tilapia (*Oreochromis niloticus*): Profitability and potential environmental impacts" during the Pond Management session. Yi is a Postdoctoral Researcher with the CRSPs Thailand Project.

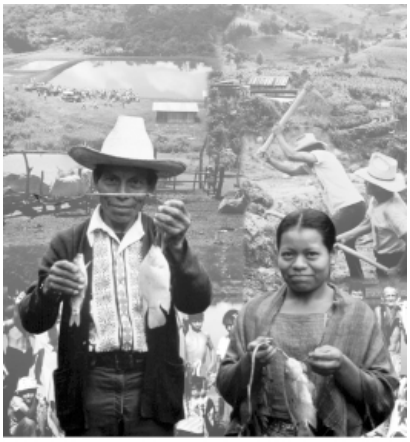
… continued on p. 11

Publication Announcement

Impact of Integrated Fish Culture on Resource Limited Farms in Guatemala and Panamá, International Center for Aquaculture and Aquatic Environments Research and Development Series No. 46, 2000, 29 pp.

Authors: Leonard L. Lovshin (Auburn University), Norman B. Schwartz (University of Delaware), and Upton Hatch (Auburn University)

Sustainability is an important factor in development projects, and is of particular importance in countries with limited resources. In this study, the authors had the "unusual opportunity to assess the ability of project participants to sustain fish culture on limited resource farms." Aquaculture development projects in Guatemala and Panamá were examined to determine level of success and ongoing sustainability. The authors found that for a variety of reasons, many farms were not able to maintain sustainable aquaculture operations and that the fish ponds did not have the intended impact on nutrition and income, due to a combination of "technical, domestic, economic, social and broad political reasons." However, the farms that remained successful, years after financial and technical support had ended, did yield important lessons on species selection, pond siting, and project strategies. This publication is the result of Eighth Work Plan Adoption / Diffusion Research (8ADR2) entitled "The influence of fish culture technology, extension methodology, and socioeconomics on success of fish culture on limited-resource farms."



To order a copy of *Impact of Integrated Fish Culture on Resource Limited Farms in Guatemala and Panamá*, see back page or contact one of the following addresses:

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Effects of Shrimp Farming Report Available

A new CRSP Research Report (#00-150) is now available. *Effects of Shrimp Farming on the Hydrography and Water Quality of El Pedregal and San Bernardo Estuaries, Gulf of Fonseca, Honduras* by George Ward (University of Texas) is a 32-page report, based on Eighth Work Plan research, addressing the effect of shrimp farm effluents on dissolved oxygen in two estuaries that are among the most developed shrimp farming areas in Honduras. Mathematical modeling is used as a tool to quantify the effects of hydrographic conditions on the ability of these water bodies to absorb the wasteloads from shrimp farming operations.

The abstract of the report appears on p. 12 under Notices of Publication. The entire report is currently available as an Acrobat PDF file at the CRSP website <pdacrsp.orst.edu / pubs / nops / ful_rprts / 00-150.pdf>. Printed copies can be ordered by sending an email to claird@ucs.orst.edu or by mailing a request to:

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ISTA 5 Proceedings Published

Tilapia Aquaculture in the 21st Century is now available. This 682-page, two-volume set of the proceedings from the Fifth International Symposium on Tilapia Aquaculture, held in Rio de Janeiro, Brazil, 3-7 September 2000, was edited by CRSP researcher Kevin Fitzsimmons and Jomar Carvalho Filho. The proceedings were published by the American Tilapia Association and Departamento de Pesca e Aqüicultura / Ministério da Agricultura e do Abastecimento (DPA / MA), with additional sponsorship from the PD / A CRSP. Copies of *Tilapia Aquaculture in the 21st Century* are now available for US$50 plus $5 shipping and handling.

For US and international orders other than Brazil, send a check or purchase order for US$55 to:
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CRSP Council Recognizes Outgoing Bean/Cowpea CRSP Director

PD/A CRSP Director Hillary Egna participated in the summer meeting of the National Association of State Universities and Land-Grant Colleges (NASULGC) Commission on International Affairs, held 26–29 July 2000 at Otter Rock, Oregon. The Commission on International Affairs of NASULGC is tasked with enlarging the international dimension of academic exchanges, research, and development programs. Goals developed by NASULGC organizations for the year 2000 include increasing and strengthening US investment in global agriculture investment and food systems development, and promoting and integrating global perspectives and international experiences into the core missions of public universities. The CRSPs contribute to attaining this goal by linking US land-grant universities with national and international research institutions.

MARTIN FITZPATRICK

CRSP Council members in attendance were (from left to right): John Yohe (International Sorghum and Millet CRSP), Tim Williams (Peanut CRSP), Tim Roth (Broadening Access and Strengthening Input Market Systems CRSP), Constance Neely (Sustainable Agriculture and Natural Resources Management CRSP), Tag Demment (Global Livestock CRSP), Irvin Widders (Bean/Cowpea CRSP), Brhane Gebrekidan (Integrated Pest Management CRSP), Hillary Egna (Pond Dynamics/Aquaculture CRSP), Pat Barnes-McConnell (Bean/Cowpea CRSP), and Goro Uehara (Soil Management CRSP).

HILLARY EGNA

Pat Barnes-McConnell enjoyed cake and festivities celebrating her service to the CRSPs.

The NASULGC meeting coincided with a meeting of the CRSP Council Steering Committee. Directors of the nine CRSPs met to discuss issues pertinent to global development. One of the highlights of the meeting was the presentation of a plaque to outgoing Bean/Cowpea CRSP Director Pat Barnes-McConnell. Barnes-McConnell was recognized for her nearly 20 years of service as Director of the Bean/Cowpea CRSP.

News from the Pond

Recent months saw great strides in CRSP extension efforts. The Kenya project had a little middle-of-the night fun helping a beginning fish farmer. The farmer had made a large investment in materials and supplies but was having problems with the water quality in his ponds. Led by Host Country Co-Principal Investigator David Liti, a group of students working at Sagana Fish Farm visited the farm and made a series of water quality analyses throughout the night. Students then developed recommendations for improving water exchange through recirculation and for aerating at proper intervals. Not only did the students benefit from the learning experience, but the farm's water quality and fish growth improved as well.

The Thailand project facilitated some global good spirits through cross-continental collaboration. Yang Yi, Research Associate at the Asian Institute of Technology, Pathumthani, Thailand, shared information with Robert Hartnell, of the United Kingdom's Department for International Development (DFID). Hartnell will conduct semi-intensive low-cost tilapia culture projects in South Africa.

In Oregon, members of the Mexico project, based at Oregon State University, helped a first-time aquaculturist get started. Students working under Martin Fitzpatrick provided juvenile Nile tilapia to a grower who is experimenting with the feasibility of hydroponics using water from a tilapia system as the main nutrient source. The farmer intends to grow basil as the second crop in his recirculating system and hopes eventually to become a tilapia fry provider in Oregon.

Doug Ernst was asked to serve on an editorial committee of the journal *Aquacultural Engineering*. Ernst, who completed his Ph.D. dissertation in the spring, continues to field extension and database questions in his role as Manager of the PD/A CRSP Central Database at Oregon State University.

Diego Valderrama, perhaps the most decorated student in PD/A CRSP history, graduated last spring from the University of Arkansas at Pine Bluff (UAPB) with a master's degree in Aquaculture/Fisheries. He has remained at UAPB as a Research Associate, working on several aquaculture economics projects. Before leaving the

EEP Visits Peru Project

by Anu Gupta

In September the PD/A CRSP External Evaluation Panel (EEP) undertook the second of three visits to CRSP sites by traveling to research and extension facilities in Peru. EEP members Kevan Main, Deputy Director of the Harbor Branch Oceanographic Institute's Aquaculture Division, in Fort Pierce, Florida, and David Cummins, former Director of the Peanut CRSP, were joined by PD/A CRSP Director Hillary Egna and USAID Project Officer Harry Rea. The visitors toured host facilities at the Instituto de Investigaciones de la Amazonia Peruana (IIAP) and the Universidad Nacional de la Amazonia Peruana (UNAP), both in Iquitos, and the IIAP Quistococha research station, located outside Iquitos. They were guided by Marcos De Jesus, the project Research Associate, and had the opportunity to meet host country project staff members Salvador Tello and Fernando Alcántara, as well as university administrators. By coincidence, Dennis del Castillo Torres, president of IIAP, was familiar with the work of the CRSPs, having previously collaborated with the Peanut, Soils Management, and SANREM (Sustainable Agriculture and Natural Resources Management) CRSPs in Africa. At Quistococha EEP members met with Palmira Padilla Perez, the IIAP aquaculturist, and other staff.

HILLARY EGNA

During a recent trip to Peru, EEP members (left to right) Dave Cummins and Kevan Main are shown a local tilapia farm by Terra Nuova community promoter Elizabeth Lozano and Peru Project researcher Marcos De Jesus.

Members of the EEP were impressed with the project, particularly by researchers' and extensionists' use of resources, which are limited outside the capital city of Lima. They found that CRSP research using locally available species and diets, led by US Regional Coordinator Chris Kohler, put together with the efforts of local extension organizations, has directly aided local farmers.

In addition to visiting host country institutions, EEP members stopped by several nearby farms active in aquaculture. On these visits, they were guided by Marco Colace of Terra Nuova, an Italian nongovernmental organization that works with farmers along the Iquitos-Nauta road. EEP members found that the relationship between Terra Nuova and the CRSP, a linkage established by Adoption/Diffusion Project Leader Joe Molnar, has been particularly beneficial to farmers along the road. They also visited farmers along the Napo River.

This site visit was part of the five-year in-depth review process required by BIFAD (Board of International Food and Agriculture Development) guidelines. In June, the EEP visited sites in Thailand, and in November they will travel to Kenya. The review process will continue through the CRSP annual meeting in Orlando, Florida, in January 2001.

CRSP, however, Valderrama received one more award: an Honorable Mention for his paper "A Risk Programming Model for Shrimp Farming in Honduras" in the Best Student Paper Competition at the International Institute of Fisheries Economics and Trade (IIFET) 2000 conference held in Corvallis, Oregon, in July.

Diego Valderrama received Honorable Mention at the IIFET 2000 conference in July.

Wes Wood, researcher on both the Kenya Project and Pond Dynamics Research, was named an adjunct graduate faculty member at the University of Nairobi, Kenya. Wood is also a faculty member in the Department of Agronomy and Soils at Auburn University, Alabama.

PD/A CRSP Contributes to ISTA 5 Success

...from p. 8

Daniel Jamu, of the International Center for Living Aquatic Resources Management (ICLARM), Zomba, Malawi, presented "A pilot study on the spatial and temporal moisture distribution in integrated crop-fish-wetland and crop-wetland agrosystem in Zomba-East, Malawi" during the Africa session. Jamu, whose presence at the meeting was sponsored by the CRSP, also represented ICLARM during the plenary session. Jamu's 1998 Ph.D. dissertation on nitrogen dynamics in integrated aquaculture/agriculture systems from the University of California, Davis, was funded by the CRSP.

In addition to providing support for host country scholars to participate in ISTA 5, the CRSP helped sponsor production of the conference proceedings (see related article, p. 9). The CRSP has been active with previous ISTA conferences and cosponsored ISTA IV, held in Orlando, Florida, in November 1997. ISTA 5 continued a history of networking between CRSP and other researchers, and more importantly, enabled the CRSP to showcase the diversity and impact of its research efforts.

Notices of Publication

These Notices of Publication announce recently published work carried out under PD/A CRSP sponsorship. To receive a full copy of a report, please contact the author(s) directly unless it is otherwise noted.

CRSP Research Report 00-150

Effects of shrimp farming on the hydrography and water quality of El Pedregal and San Bernardo estuaries, Gulf of Fonseca, Honduras*

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Intensive data collection and a modeling study have been underway for the past several years addressing two of the channel estuaries draining into the Gulf of Fonseca, Estero El Pedregal and Estero San Bernardo. Data have been compiled on the shrimp farm configurations, exchange rates, and effluent chemistry. Temperature, salinity, and dissolved oxygen profiles have been measured in the estuary channels during both rainy and dry seasons. Physiographic, hydrographic, and meteorological data have been obtained to supplement the estuary data. This report examines the assimilative capacity of these estuaries with respect to dissolved oxygen (DO). The oxygen demand of organics is measured by biochemical oxygen demand (BOD). Shrimp farm BOD loadings were estimated from effluent data and exchange. A transport model for salinity and DO in the estuaries was applied to predict the tidal-mean and section-mean concentrations of salinity and DO. The model predictions of DO—based on 1995 BOD loadings—were satisfactory. Future loadings based upon full shrimp farm development along these two estuaries were then input to determine the resulting DO under these conditions. It was found that the 1995 configuration is already pressing the carrying capacity of both systems, and the DO will be worse at full development. Shrimp farms placed farther upstream than about 20 km from the mouth will most likely have excessive impact on the DO in the estuary, which is exacerbated under dry-season conditions. Negative impacts of a specific farm can be ameliorated by reducing or eliminating pond discharges during the dry season and by reducing the level of water exchange employed. This work needs to be extended to address additional water quality parameters and to incorporate larger spatial scales, especially to establish the interaction between different estuaries draining into Fonseca.

*To order this publication, contact:
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CRSP Research Report 00-151

Chemical and physical properties of shrimp pond bottom soils in Ecuador

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Chemical and physical analyses were conducted on bottom soil samples from 74 brackish-water ponds representing 40 shrimp farms in Ecuador. Most ponds had soils with pH > 6 and total carbon concentrations < 2.5%. Carbon was mostly in organic form, for the average concentration of carbonate carbon was 0.06%. The C : N ratio was 8 to 10 in soils with < 2.5% carbon. In ponds built in former mangrove areas, soil carbon was > 2.5% and C : N ratios were 25 to 30. Ponds soils in former mangrove areas also tended to be high in total sulfur and low in pH. Lack of correlation between carbon and sulfur in mangrove soils suggested that most of the sulfur was inorganic and presumably in sulfides. Soils containing above 0.4% free carbonate (as equivalent $CaCO_3$) had pH values > 7. Although carbonate concentration was a major factor controlling soil pH, calcium hardness of pond waters was strongly influenced by salinity (and calcium) in the water supply. Total phosphorus concentrations averaged 898 mg/kg, and dilute acid extractable phosphorus usually accounted for 25–35% of the total. Concentrations of major cations and minor elements varied greatly in soils and exhibited ranges of up to three orders of magnitude. Contrary to opinions of shrimp producers, many pond soils in Ecuador are not acidic and few soils have a high organic matter content. Proper use of soil and water testing could greatly improve the efficiency of liming and other soil management practices.

This abstract was excerpted from the original paper, which was published in the Journal of the World Aquaculture Society, 31(3):358–375.

Notices of Publication (cont.)

CRSP Research Report 00-152

VERTICAL GRADIENTS OF ORGANIC MATTER CONCENTRATION AND RESPIRATION RATE IN POND BOTTOM SOILS

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Total carbon concentration and respiration rate were greater in the upper 0.5-cm or 1.0-cm layers of pond soil than in deeper layers. The respiration rate expressed on either a dry soil weight basis or a soil carbon basis decreased with increasing soil depth. This suggests that the ratio of labile to refractory organic matter also declines with increasing soil depth. Variation in soil properties with depth should be considered in pond bottom soil sampling programs.

This abstract was excerpted from the original paper, which was published in the Journal of the World Aquaculture Society, 31(3):376–380.

CRSP Research Report 00-153

DEVELOPMENT OF DECISION SUPPORT TOOLS FOR AQUACULTURE: THE POND EXPERIENCE

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Decision support systems (DSS) are potentially valuable tools for assessing the economic and ecological impacts of alternative decisions on aquaculture production. In this paper, we discuss the philosophy of design, functional modules and application areas of POND, a decision tool that has been developed to allow analysis of pond aquaculture facilities by the use of a combination of simulation models and enterprise budgeting. We focus less on the details of POND's internal models, and more on the experiences we have gained from going through the process of the designing, developing and using the POND software. POND was designed and implemented using object-oriented programming principles. The software makes use of a simulation framework to provide much of the generic simulation, data handling, time flow synchronization and communication features necessary for complex model-based DSSs. Additionally, an architecture suitable for representing and manipulating pond aquaculture facilities was developed in order to meet the design specifications of POND. This architecture includes a series of mini-databases, a number of knowledge-based components ('experts'), models of the pond ecosystem, and various decision support features (e.g. assembling alternate management scenarios, economic analysis, and data visualization). A typical POND simulation consists of assembling a number of appropriate objects or entities (e.g. multiple ponds and fish lots), their management settings together with appropriate experts (e.g. an aquaculture engineer, an aquatic biologist, an economist, etc.), and projecting changes in the facility over time. Our experience with the development of POND and other simulation-based tools indicates that the object-based approach provides a robust foundation for developing tools which allow code reusability, facilitate maintenance of complex software, and enable partition of program development among multiple programmers. Experience gained with POND users suggests that there are largely two groups of aquaculture personnel interested in such applications, namely commercial growers and educators. These two groups have substantially different interests and needs. Consequently, a single tool such as POND may not optimally meet the requirements of both groups. Recent development work on POND, and the need to involve users in the design process of such tools are discussed.

This abstract was excerpted from the original paper, which was published in Aquacultural Engineering, 23(1–3):103–119.

Notices of Publication (cont.)

CRSP Research Report 00-154

AquaFarm: Simulation and decision support for aquaculture facility design and management planning

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Development and application of a software product for aquaculture facility design and management planning are described (AquaFarm, Oregon State University©). AquaFarm provides: (1) simulation of physical, chemical, and biological unit processes; (2) simulation of facility and fish culture management; (3) compilation of facility resource and enterprise budgets; and (4) a graphical user interface and data management capabilities. These analytical tools are combined into an interactive, decision support system for the simulation, analysis, and evaluation of alternative design and management strategies. The quantitative methods and models used in AquaFarm are primarily adapted from the aquaculture science and engineering literature and mechanistic in nature. In addition, new methods have been developed and empirically based simplifications implemented as required to construct a comprehensive, practically oriented, system level, aquaculture simulator. In the use of AquaFarm, aquaculture production facilities can be of any design and management intensity, for purposes of broodfish maturation, egg incubation, and/or growout of finfish or crustaceans in cage, single pass, serial reuse, water recirculation, or solar-algae pond systems. The user has total control over all facility and management specifications, including site climate and water supplies, components and configurations of fish culture systems, fish and facility management strategies, unit costs of budget items, and production species and objectives (target fish weights/states and numbers at given future dates). In addition, parameters of unit process models are accessible to the user, including species-specific parameters of fish performance models. Based on these given specifications, aquaculture facilities are simulated, resource requirements and enterprise budgets compiled, and operation and management schedules determined so that fish production objectives are achieved. When facility requirements or production objectives are found to be operationally or economically unacceptable, desired results are obtained through iterative design refinement. Facility performance is reported to the user as management schedules, summary reports, enterprise budgets, and tabular and graphical compilations of time-series data for unit process, fish, and water quality variables. Application of AquaFarm to various types of aquaculture systems is demonstrated. AquaFarm is applicable to a range of aquaculture interests, including education, development, and production.

This abstract was excerpted from the original paper, which was published in Aquacultural Engineering, 23(1–3):121–179.

CRSP Research Report 00-155

Applications of geographical information systems (GIS) for spatial decision support in aquaculture

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Geographical information systems (GIS) are becoming an increasingly integral component of natural resource management activities worldwide. However, despite some indication that these tools are receiving attention within the aquaculture community, their deployment for spatial decision support in this domain continues to be very slow. This situation is attributable to a number of constraints including a lack of appreciation of the technology, limited understanding of GIS principles and associated methodology, and inadequate organizational commitment to ensure continuity of these spatial decision support tools. This paper analyzes these constraints in depth, and includes reviews of basic GIS terminology, methodology, case studies in aquaculture and future trends. The section on GIS terminology addresses the two fundamental types of GIS (raster and vector), and discusses aspects related to the visualization of outcomes. With regard to GIS methodology, the argument is made for close involvement of end

Notices of Publication (cont.)

users, subject matter specialists and analysts in all projects. A user-driven framework, which involves seven phases, to support this process is presented together with details of the degree of involvement of each category of personnel, associated activities and analytical procedures. The section on case studies reviews in considerable detail four aquaculture applications which are demonstrative of the extent to which GIS can be deployed, indicate the range in complexity of analytical methods used, provide insight into issues associated with data procurement and handling, and demonstrate the diversity of GIS packages that are available. Finally, the section on the future of GIS examines the direction in which the technology is moving, emerging trends with regard to analytical methods, and challenges that need to be addressed if GIS is to realize its full potential as a spatial decision support tool for aquaculture.

This abstract was excerpted from the original paper, which was published in Aquacultural Engineering, 23(1–3):233–278.

CRSP Research Report 00-156

Response to selection for body weight of Nile tilapia (*Oreochromis niloticus*) in different culture environments

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Within-family selection was practiced in Nile tilapia (*Oreochromis niloticus*) for 12 generations to increase body weight at 16 weeks of age. Response to selection was evaluated based on the progenies from two selected generations (S_{10}, S_{13}). Two variants of control lines (random-bred control and mean selected control) were used to account for environmental changes during the course of the selection experiments. A genetically improved strain (GIFT strain) and a commercial strain (Israel strain) were included in the performance evaluation. Eight experiments were conducted between 1993 and 1997. The different test groups were stocked communally in tanks, hapas, and ponds. Results showed that the selected group consistently had higher final body weights in the three test culture environments. The highest response was observed in the selection environment (tanks). A higher response occurred in the tanks for S_{10} (68% as deviation from the RBC group) and the response was still substantial at S_{13}. A significant interaction was observed in the 1996 GxE study but this can be attributed to a scale effect, a change in the magnitude of growth difference within group from one environment to another. In this study, the pond environment provided more optimal condition for growth than the tank and hapa environments. The results of 1993 and 1997 GxE analyses did not show significant test group x environment interaction. Overall, the results of these growth evaluations showed that the selected group produced from within-family selection had improved growth performance and the selection response achieved in the tanks was apparent in hapa and pond environments.

This abstract was excerpted from the original paper, which was published in K. Fitzsimmons and J. Carvalho Filho (Editors), Tilapia Aquaculture in the 21st Century, Fifth International Symposium on Tilapia Aquaculture. American Tilapia Association and Departamento de Pesca e Aqüicultura / Ministério da Agricultura e do Abastecimento, Rio de Janeiro, Brazil, pp. 12–23.

CRSP Research Report 00-157

Criteria for selecting Nile tilapia and red tilapia for culture

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Tilapia farmers often have problems deciding if Nile tilapia or red tilapia is the proper choice for culture. Nile tilapia is the most widely farmed tilapia world-wide but interest in red tilapia culture is growing rapidly. Nile tilapia are more dependable spawners and produce more consistent quantities of fry than red tilapia. Survival of eggs, fry and juveniles is higher for Nile tilapia and Nile tilapia are more tolerant of low water temperatures than most strains of red tilapia. Red tilapia often have higher market value, are more appropriate for culture in salinities above 10 g / l, and are easier to seine harvest from earthen ponds and transport live than Nile tilapia. Red tilapia need continual selection to retain their red color and pass the red color from generation to generation. Farmers should evaluate environmental conditions, culture system and markets before selecting either Nile tilapia or red tilapia for culture.

This abstract was excerpted from the original paper, which was published in K. Fitzsimmons and J. Carvalho Filho (Editors), Tilapia Aquaculture in the 21st Century, Fifth International Symposium on Tilapia Aquaculture. American Tilapia Association and Departamento de Pesca e Aqüicultura / Ministério da Agricultura e do Abastecimento, Rio de Janeiro, Brazil, pp. 49–57.

Notices of Publication (cont.)

CRSP Research Report 00-158

Timing of the onset of supplemental feeding of Nile tilapia (*Oreochromis niloticus*) in ponds

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An on-farm trial was conducted in seven (7) farms in Nueva Ecija, Philippines, to investigate the effect of two onsets of feeding on the growth, yield and survival of Nile tilapia. There were no significant differences on the performance data (final mean weight, daily weight gain, extrapolated gross fish yield, and survival rate) that were recorded in this study. The only statistically significant difference observed was in the total quantities of feed used in the trial. The 45-day onset in feeding produced a slightly higher mean gross value of the crop (P205,617 ha^{-1}) compared with the 75-day delay (P197,063 ha^{-1}) but by delaying the start of feeding, the costs were reduced such that the net value of the crop was improved (P124,242 ha^{-1} in 75-day vs. P106,026 ha^{-1} in 45-day delay).

This abstract was excerpted from the original paper, which was published in K. Fitzsimmons and J. Carvalho Filho (Editors), Tilapia Aquaculture in the 21st Century, Fifth International Symposium on Tilapia Aquaculture. American Tilapia Association and Departamento de Pesca e Aqüicultura / Ministério da Agricultura e do Abastecimento, Rio de Janeiro, Brazil, pp. 237–240.

CRSP Research Report 00-159

Analyses of various inputs for pond culture of Nile tilapia (*Oreochromis niloticus*): Profitability and potential environmental impacts

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This paper presents profitability analyses and potential environmental impacts for Nile tilapia culture in ponds with a series progressive inputs. The sequential experimental stages to increase fish production through intensification were: 1) TSP only; 2) chicken manure only; 3) chicken manure supplemented with urea or urea and TSP; 4) urea and TSP; 5) continually supplemental feeding; 6) staged supplemental feeding; 7) feed alone.

Profitability analyses showed that the choices of input regimes with increasing economic gains are: 1) fertilizing ponds with moderate loading of chicken manure; 2) fertilizing ponds with chicken manure supplemented with urea and TSP to balance nutrient loading and maintain water quality; 3) fertilizing ponds with urea and TSP at appropriate rates; 4) fertilizing ponds initially with urea and TSP, in combination with supplemental pelleted feed at 50% satiation level at later stage of grow-out cycle.

The analyses indicated that intensification of tilapia culture through staged inputs in ponds improved efficiency in land use and water consumption. The analyses also showed that the rate of nutrient loss as wastes and the nutrients required to produce 1 kg tilapia were markedly less in ponds with supplemental feed than those with high rate of fertilizer inputs.

This abstract was excerpted from the original paper, which was published in K. Fitzsimmons and J. Carvalho Filho (Editors), Tilapia Aquaculture in the 21st Century, Fifth International Symposium on Tilapia Aquaculture. American Tilapia Association and Departamento de Pesca e Aqüicultura / Ministério da Agricultura e do Abastecimento, Rio de Janeiro, Brazil, pp. 247–257.

Notices of Publication (cont.)

CRSP Research Report 00-160

Concurrent design of hillside ponds for tilapia production

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Farming on hillsides in Latin America has resulted in progressive deterioration of natural resources due to a combination of overgrazing, poor farming practices, deforestation, and poor water management. The introduction of tilapia production could improve the nutrition of farm families and local communities and provide a means of additional earning for improving economic status. An important aspect of designing and successfully introducing tilapia in Honduras and the adjoining regions is to have all stakeholders identify needs that include technical requirements as well as social and environmental issues important in the design of ponds and the production of tilapia. The fundamental method of pond design used here was based on the principles of concurrent engineering design methodology. In this method all stakeholders, hereafter referred to as "customers" (a person or entity that can impact the building, maintenance, and use of ponds for tilapia production), are identified. Our customer list included Honduras farmers, extension agents, government agencies, nongovernmental organizations, builders, and design engineers. Customer needs were identified and prioritized based on information from literature and input from experts representing perspectives of the identified customers. Design concepts were then tested using a US National Resource Conservation Service runoff model and spatial data pieced into a Geographical Information System. Concurrently considering needs of all customers in the design and selection of construction method provides a powerful method to have the user educated and invested in the design. This approach presents an increased possibility of introducing acceptable pond design and tilapia production as an economic enterprise in Honduras and Central America.

This abstract was based on the original paper, which was published in K. Fitzsimmons and J. Carvalho Filho (Editors), Tilapia Aquaculture in the 21st Century, Fifth International Symposium on Tilapia Aquaculture. American Tilapia Association and Departamento de Pesca e Aqüicultura / Ministério da Agricultura e do Abastecimento, Rio de Janeiro, Brazil, pp. 311–315.

CRSP Research Report 00-161

Microbiological hazards of tilapia culture systems

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Fecal coliform levels were measured in seven freshwater fish culture systems to assess potential microbiological hazards. Over a two month period, fecal coliform concentrations in two tilapia research facilities varied from 1 to 10^4 colony forming units (CFU) per 100 ml of water, at a mean level that could indicate the presence of human pathogens that may be hazardous to fish handlers and consumers. Over a one-month period, five commercial systems were found to contain *Escherichia coli*, *Clostridium perfringens*, Enterococci, and fecal coliforms. The concentration of fecal coliforms at the commercial sites was higher than the level found at the research facility. The presence of such organisms creates a potential for microbiological hazards in these systems. No *Salmonella* was detected in the systems. The source of these indicator organisms was not determined, nor were any host organisms obvious in the system. The findings in this study indicate that monitoring fish culture facilities for microbiological safety should be considered. In addition, workers should be aware of personal hygiene when entering, while working in, and when departing fish culture facilities.

This abstract was excerpted from the original paper, which was published in K. Fitzsimmons and J. Carvalho Filho (Editors), Tilapia Aquaculture in the 21st Century, Fifth International Symposium on Tilapia Aquaculture. American Tilapia Association and Departamento de Pesca e Aqüicultura / Ministério da Agricultura e do Abastecimento, Rio de Janeiro, Brazil, pp. 479–485.

Upcoming Conferences and Expositions

Date	Topic/Title	Event Location	Contact Information
November 6–10	53rd Annual Meeting of the Gulf and Caribbean Fisheries Institute	Biloxi, Mississippi, USA	LeRoy Creswell, GCFI, INC., c/o HBOI, 5600 US Hwy. 1 North, Ft. Pierce, FL 34946; Phone: 561-465-2400; Fax: 561-466-1506; Email: creswell@hboi.edu; Website: <www.ims.usm.edu/gcfi>
November 9–12	AgAsia 2000	Bangkok, Thailand	Email: agasia@reedtradex.co.th; Website: <www.reedtradex.co.th/agasia2000/main.html>
November 14–17	FISHERY 2000	Jakarta, Indonesia	Phone: 852-2851-8603; Fax: 852-2851-8637; Email: topreput@hkabc.net
November 19–22	V International Symposium on Aquaculture Nutrition	Yucatan, Mérida, Mexico	Dr. Miguel A. Olvera Novoa; Phone: 52-99-812973; Fax: 52-99-812334; Email: sinav@kin.cieamer.conacyt.mx
November 20–25	Fifth International Aquarium Congress	Monaco	Nadia Ounais, Musée Océanographique, Avenue St-Martin, MC-98000 Monaco; Phone: +377-93-15-36-00; Fax: +377-93-30-90-95; Email: iac2000monaco@meditnet.com; Website: <www.musee-oceano.mc>
November 22–25	Diseases in Asian Aquaculture, 4th Symposium	Cebu City, Philippines	Fax: +63-33-3351009; Email: afs_fhs@seafdec.org.ph
November 29–December 5	Expo Pesca 2000 & Acuicultura 2000	Santiago, Chile	Phone: 509-838-8755; Fax: 509-838-2838; Email: sue.hill@informa.com
December 5–8	Environmental Strategies for Aquaculture Systems: Midwest Fish & Wildlife Conference	Minneapolis, Minnesota, USA	Phone: 906-228-4830; Email: kinnunen@msu.edu
December 7–9	Northeast Aquaculture Conference and Exposition	Portland, Maine, USA	Phone: 888-454-7469; Email: show@nbnet.nb.ca
January 11–13, 2001	Marine Aquaculture and the Environment: A Meeting for Stakeholders in the Northeast	Boston, Massachusetts, USA	Ms. Florence Wurtzel, ECOS/Workshop, University of Massachusetts, 100 Morrissey Blvd., Boston, MA 02125-3393; Phone: 617-287-7440; Email: timothy.odonnell@umb.edu; Website: <alpha.es.umb.edu/mae01/>
January 21–25, 2001	Aquaculture 2001	Orlando, Florida, USA	WAS Conference Manager, World Aquaculture Society, 2423 Fallbrook Place, Escondido, CA 92027, USA; Phone: 760-432-4270; Fax: 760-432-4275; Email: worldaqua@aol.com; Website: <www.was.org/meetings/wasmeetings.html>
February 1–2, 2001	Fish Farming Trade Show	Greenville, Mississippi, USA	Mike McCall; Phone: 601-714-5327; Email: catfisj@aol.com
April 26–28, 2001	Acquacoltura International 2001	Verona, Italy	Maurizio Rosellini, Veronfiere, Viale del Lavoro 8 - C.P. 525, 37100 Verona, Italia; Phone: +39-0-45-829-8235; Email: info@veronafiere.it; Website: <www.veronafiere.it>
May 6–9, 2001	Aquaculture Canada '01	Halifax, Nova Scotia, Canada	Linda Hiemstra, Aquaculture Association of Canada, 16 Lobster Lane, St. Andrews, NB, Canada E5B 3T6; Phone 506-529-4766; Email: hiemstra@mala.bc.ca
May 20–25, 2001	Indo-Pacific Fish Conference	Durban, South Africa	The South African Association for Marine Biological Research, PO Box 10712, Marine Parade 4056, Durban, South Africa; Phone: +27-31-337-3536; Fax: +27-31-337-2132; Email : seaworld@dbn.lia.net; Website: <www.seaworld.org.za/>
June 1–3, 2001	Open Ocean Aquaculture IV	St. Andrews, New Brunswick, Canada	Chris Bridger; Phone: 228-875-9341; Email: ooa@usm.edu
August 19–23, 2001	131st American Fisheries Society Annual Meeting	Phoenix, Arizona, USA	Betsy Fritz; Phone: 301-897-8616 ext. 212; Email: bfritz@fisheries.org

Workshops and Short Courses

Date	Title/Topic/Site	Contacts
November 12–15	Design and Operation of Aquaculture Facilities / The Hotel Roanoke Conference Center, Roanoke, Virginia, USA	Dr. Greg Boardman, Phone: 540-231-2013; Email: gboard@vt.edu; Website: <www.conted.vt.edu / doaf.htm>
November 13–17	Recirculating Aquaculture Systems / ACTED	Aquaculture Center for Training, Education, and Demonstration (ACTED); Contact: Harbor Branch Oceanographic Institution, 5600 US Hwy 1 North, Ft. Pierce, FL 34946; Phone: 800-333-4264 or 561-465-2400 ext. 416; Fax: 561-466-6590; Email: acted@hboi.edu; Website:<www.aquaculture-online.org>
November 20–21	Workshop on New Species for Aquaculture / Faro, Portugal	Maria Teresa Dinis, University of Algarve, CCMAR UCTRA, Campus de Gambelas, 8000-810 Faro, Portugal; Fax: +351-289-818353; Email: newspec@ualg.pt; Website: <www.ualg.pt / uctra / newspec>
November 20–29	Advanced Freshwater Farming Technologies / Israel Aquaculture Academy	Israel Aquaculture Academy; Email: fish@atidtec.co.il
November 29–December 1	Workshop on Sea Urchin Aquaculture / Torregrande, Sardinia, Italy	Donatella Marchi, International Marine Centre, Loc. Sa Mardini, Torregrande, Oristano, Sardinia, Italy; Phone: 39-0783-22-27; Fax: 39-0783-22002; Email: urchin@imc-it.org; Website: <www.imc-it.org / seaurchin>
December 6–8	Opportunities in Aquaculture / ACTED	ACTED (see above)
February 7–8, 2001	OSU-ENSIA Surimi Technology School / Paris, France	Jae Park; Email: jae.park@orst.edu or surimischool@aol.com; Website: <osu.orst.edu / dept / seafood / surimi>
March 5–30, 2001	Advances in Tilapia Fry Production and Grow-out / Pathumthani, Thailand	Training and Consultancy Unit (TCU), Aquaculture and Aquatic Resources Management Program, Asian Institute of Technology, PO Box 4, Klong Luang, Pathumthani 12120, Thailand; Phone: 66-2-524-5219; Fax: 66-2-524-5484; Email: tcuaasp@ait.ac.th; Website: <www.agri-aqua.ait.ac.th / tcu>
April 10–12, 2001	OSU Surimi Technology School / Astoria, Oregon, USA	Jae Park, Email: jae.park@orst.edu or surimischool@aol.com; Website: <osu.orst.edu / dept / seafood / surimi>
April 23–May 18, 2001	Hatchery Management for Finfish / Pathumthani, Thailand	Training and Consultancy Unit (see above)
May 28–June 15, 2001	Seabass Seed Production / Pathumthani, Thailand	Training and Consultancy Unit (see above)
June 7–16, 2001	Inland Aquaculture Study Tour / Pathumthani, Thailand	Training and Consultancy Unit (see above)
June 25–July 27, 2001	Black Tiger Shrimp Hatchery Techniques / Pathumthani, Thailand	Training and Consultancy Unit (see above)
August 14–September 14, 2001	Giant Fresh Water Prawn Hatchery Techniques / Pathumthani, Thailand	Training and Consultancy Unit (see above)
Various dates from June to November, 2001	Integrated Tropical Coastal Zone Management Courses / Pathumthani, Thailand	Training and Consultancy Unit (see above)
Ongoing	Tailor-made training courses / Pathumthani, Thailand	Training and Consultancy Unit (see above)
Year-round	Tropical Aquaculture Advanced Training in a Third World Country / Escuela Agrícola Panamericana (EAP), Honduras, and Asian Institute of Technology, Thailand	Zentralstelle fuer Ernahrung und Landwirtschaft (ZEL) Feldafing / Zschortau, Deutsche Stiftung fuer Internationale Entwicklung (DSE), D-82336 Feldafing, Germany; Phone: 49-8157-938-0; Fax: 49-8157-938-777

New Aquaponics/Tilapia Short Course

The University of the Virgin Islands (UVI) will be offering a 7-day course in Aquaponics and Tilapia Aquaculture 24 to 30 June 2001. For more information and to register, contact Dr. James Rakocy, RR 2, Box 10,000, Kingshill, VI 00850; Phone: 340-692-4020; Email: jrakocy@uvi.edu. Or visit the short course website at <rps.uvi.edu / AES / Aquaculture / UVIShortCourse.html>.

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